

METHOD FOR MANUFACTURING AND/OR REPAIRING
COMPONENTS FOR GAS TURBINES

The present invention relates to a method for manufacturing and/or repairing components, particularly blades and blade segments, for gas turbines, particularly for aircraft engines.

5 Modern gas turbines, particularly aircraft engines, must satisfy the highest demands with respect to reliability, weight, performance, economic efficiency and durability. In the last decades, aircraft engines were developed, particularly in the civil sector, which fully satisfy the
10 above requirements and have achieved a high degree of technical perfection. Among other things, the selection of materials, the search for new suitable materials and the search for new manufacturing methods and repair methods play a decisive role in the manufacture and also in the repair of
15 aircraft engines.

Numerous methods for manufacturing and repairing components for gas turbines are known from the related art. This includes, among other things, forging and investment casting.
20 Thus, according to the related art, all highly stressed components in the compressor region of a gas turbine are manufactured by forging, whereas the rotor blades, for example, as well as the stator blades of the turbine are investment casting parts. Particularly milling from the solid
25 or joining of finished blades to a rotor holder or a hub by linear friction welding are used in the manufacture of gas turbine rotors having integral blading, of so-called blisks (bladed disks) or blings (bladed rings).

30 Another method known from the related art for manufacturing and repairing or restoring blades for gas turbines is the so-

called laser-powder build-up welding, which is also called laser beam build-up welding or laser beam generation.

According to the related art, laser-powder build-up welding is used particularly in maintenance work and restoration work.

5 Thus it is known from the related art for blades, which have a short blade length as a result of wear, to be restored by laser-powder build-up welding so that the blades may be reinstated more frequently and consequently do not have to be sorted out prematurely.

10 A method for manufacturing or restoring blades for turbo engines by laser beam build-up welding is known from DE 195 47 903 C1. In the method disclosed therein, a strip of sheet metal is used as a support form. Following the
15 extension of the blade by laser build-up welding, the sheet metal strip is removed and reused.

Using this as a starting point, the present invention is geared toward the objective of providing a novel method for
20 manufacturing and/or repairing components for gas turbines.

This objective is attained in that the method mentioned at the outset is refined by the features of the characterizing part of Claim 1.

25 According to the present invention, laser-powder build-up welding is performed using at least one substructure, the material build-up by a powder material occurring in the process of laser-powder build-up welding in such a way that
30 the or every substructure is at least in sections enclosed by the built-up powder material. Following the laser-powder build-up welding, the substructure used in the method according to the present invention remains inside the manufactured or repaired component and thereby becomes an
35 integral part of it. This results in a multitude of new

design possibilities for gas turbine components, particularly for stator blades, rotor blades, stator blade segments, rotor blade segments or rotors having integral blading for aircraft engines.

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According to an advantageous further development of the present invention, a blade for a gas turbine is manufactured in that in laser-powder build-up welding a substructure made of a dampening material is enclosed on all sides by the built-up powder material such that the substructure is subsequently positioned in the interior of the manufactured blade. The blade is in particular a hollow blade for a gas turbine, the dampening substructure preferably completely filling a hollow space of the manufactured hollow blade.

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According to an alternative advantageous further development of the present invention, a gas turbine rotor having integral blading is manufactured in that a substructure made of forged, cast or powder-metallurgically manufactured material is enclosed by the built-up powder material in the process of laser-powder build-up welding.

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Another method according to the present invention for manufacturing and/or repairing components for gas turbines is characterized by the features of independent Claim 11.

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Preferred further developments of the method according to the present invention are revealed by the dependent claims and the following description.

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Exemplary embodiments of the present invention are explained in detail in light of the drawing without being limited to it. The figures in the drawing show:

Fig. 1: a cross section of a blade of a gas turbine in a schematized perspective lateral view;

Fig. 2: a blade segment of a gas turbine in a schematized perspective lateral view; and

Fig. 3: a gas turbine rotor having integral blading in a schematized perspective lateral view.

In the following, the present invention will be described in greater detail with reference to Fig. 1 through 3. Fig. 1 shows a blade of a gas turbine manufactured using the method according to the present invention. Fig. 2 shows a blade segment, and Fig. 3 shows an integrally bladed gas turbine rotor.

Fig. 1 shows a rotor blade 10 for a gas turbine comprising a blade root 11 and a blade 12. Fig. 1 shows a cross section of blade 12, it being possible to gather from Fig. 1 that rotor blade 10 takes the form of a hollow blade 10. A wall 13 of blade 12 delimits a hollow space 14, a core 15 made of a preferably dampening material being situated in hollow space 14. In the exemplary embodiment shown, core 15 made of a dampening material completely fills hollow space 14.

In accordance with the present invention, rotor blade 10 as shown in Fig. 1 is manufactured in that core 15 made of a dampening material is used as a substructure for laser-powder build-up welding. According to the present invention, the material build-up occurs in the process of laser-powder build-up welding in a manner such that substructure or core 15 is enclosed by the built-up powder material. Substructure or core 15 thus becomes an integral part of rotor blade 10 to be manufactured. In the exemplary embodiment shown in Fig. 1, core 15 is enclosed on all sides by the built-up powder

material. As already mentioned, core 15 is made of a dampening material which is preferably manufactured as a metallic or ceramic felt.

5 Fig. 2 shows a blade segment 16, manufactured with the aid of the method according to the present invention, having altogether four blades 17, an inner cover strip 18 and an outer cover strip 19. Thus blade segment 16 as shown in Fig. 2, for example, may be a blade segment whose individual blades
10 17 in analogy with blade 10 as shown in Fig. 1 take the form of hollow blades having cores embedded in their hollow spaces.

Alternatively it is also possible, however, to manufacture blade segment 16 as shown in Fig. 2 by using in each case one
15 cast, forged or powder-metallurgically manufactured substructure both for inner cover strip 18 and for outer cover strip 19, the individual blades 17 being built up on these substructures by laser-powder build-up welding.

20 Fig. 3 shows a gas turbine rotor 20 having integral blading, multiple rotor blades 22 being joined to a disk-shaped rotor holder 21. Rotor blades 22 are attached to an outer lateral surface 23 of disk-shaped rotor holder 21 and extend in the radial direction of the same outward.

25 Gas turbine rotor 20 shown in Fig. 3 having a disk-shaped rotor holder 21 having integral rotor blades 22 is also called a blisk (bladed disk).

30 In accordance with the present invention, gas turbine rotor 20 shown in Fig. 3 is manufactured in that for rotor holder 21 a forged, cast or powder-metallurgically manufactured disk member made of metal is used, rotor blades 22 being built up on this disk-shaped substructure by laser-powder build-up
35 welding.

It is furthermore in accordance with the present invention for gas turbine rotor 20 alternatively to be manufactured by using the forged, cast or powder-metallurgically manufactured

5 substructure for the rotor holder and also for the rotor blade substructures. In this exemplary embodiment, the substructure for rotor holder 21 is preferably a metallic substructure and the substructures for rotor blade 22 are ceramic substructures. The metallic substructure of the rotor holder

10 and the ceramic substructures of rotor blade 22 are then integrally joined in accordance with the present invention by laser-powder build-up welding, the powder-material to be built-up by welding enclosing the substructure for rotor holder 21 as well as the substructures for rotor blades 22 on

15 all sides following the process of laser-powder build-up welding. Accordingly, an integral or form-locking joint between ceramic components and metallic components is realizable with the aid of the present invention.

20 From the details of the method according to the present invention described in connection with Fig. 1 through 3 it directly follows that the method according to the present invention opens up a multitude of design possibilities for gas turbine components. With the aid of the method according to

25 the present invention it is thus possible to manufacture hollow blades around a core made of dampening material by laser-powder build-up welding. Furthermore it is possible to manufacture blades, blade segments or gas turbine rotors having integral blading with and without cover strip by

30 embedding cast, forged or powder-metallurgically manufactured substructures into the powder material or laser powder. It is furthermore possible to join components made of different materials in an integral manner. For this purpose, according to the present invention, laser-powder build-up welding is

35 performed using at least one substructure, the material build-

up by the powder material occurring in the process of laser-powder build-up welding in such a way that the or every substructure is at least in sections enclosed by the built-up powder material.

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It is furthermore in accordance with the present invention for the laser-powder build-up welding to be carried out in multiple stages or steps, different materials, that is, different powder materials, being used for the laser-powder build-up welding in the individual stages or steps. Metal alloys are preferably used as powder materials, such as nickel-based alloys or titanium-based alloys for example. Due to the division of the laser-powder build-up welding into multiple stages and the use of different powder materials it is possible to construct subassemblies, particularly blades, for gas turbines from different metal alloys and thus to optimize the properties of the same. Thus in repairing a blade it is also possible to extend the blade by building up the extension by welding from a different material than the material of the blade. It is furthermore possible to use different materials for the rotor blades and the rotor holder in manufacturing integrally bladed gas turbine rotors.

As already mentioned repeatedly, the method according to the present invention is suited for manufacturing individual blades, for manufacturing blade segments, for manufacturing gas turbine rotors having integral blading and for manufacturing other components for gas turbines. Thus it is also possible for example to manufacture fastening elements or housing sections for gas turbines using the method according to the present invention. The blade segments can be constructed with or without a cover strip and may comprise at least two blades.

It should be pointed out in conclusion that the details of laser-powder build-up welding are familiar to the person skilled in the art addressed here. Very briefly only it should be pointed out that in laser-powder build-up welding
5 the powder material is sprayed from a powder gun onto the substructure and that a laser beam heats the powder material such that the powder material is joined with the substructure or is built up by welding.